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DISCUSSION

REMARKS ON THE THEORY OF THE PITOT TUBE

By N. W. Akimoff

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Mr. J. W. Le Doux: There has been recently a large amount of discussion of the apparatus known as "Pitot tube," the points of greatest interest being the shape and arrangement of the openings; the methods of calibration; the influence of disturbing factors; the formula of flow, particularly as to the term "g" representing the acceleration of gravity, and the constancy of the coefficient throughout the range of the velocity.

In regard to the first it would seem to the writer that as any particular form requires calibration, that which is the simplest and easiest to handle, offers no material obstruction to the flowing water and produces the highest deflection of head for a given velocity should be the most satisfactory.

It has been held that the results are different if a tube is moved in still water from what they are if the tube is stationary and the water moves. It is hard to see how this can be so providing the conditions are alike in each case, for instance: if a long column of water of the same uniform cross section be used for each determination. If a Pitot tube be made to advance at uniform speed through the center of a canal of uniform cross section, the coefficient thus determined should be the same as if the Pitot tube were stationary in the same relative position and the column of water advanced at the same velocity. If, however, the coefficient were determined under the first of these conditions and afterwards placed in a circular pipe under pressure, it is conceivable that the coefficient would be different, although if moving and still water determinations could be made for the pipe itself, the results might be the same.

The influence of disturbing factors, such as the proximity of fittings or variation in the shape of the conduit or pipe, can never be allowed for in advance, and the proper thing to do is to avoid them as far as possible.

The formula of a Pitot tube, as well as that of the flow through all orifices or contractions in a pipe, is almost universally recognized to be that of a parabola, which is the simplest formula of a conic section, there being but two terms and two variables, one of these being in the first power and the other in the second. The first variable is the head or pressure, and the second the velocity, or quantity flowing. This parabola formula can be placed in the form of

$v^2 = c\,h$, in which

h is the head
v is the velocity
c is a constant.

If this formula is true and c is a true constant, it is only necessary to obtain the value of h and v experimentally which will determine c by calculation, and when this is once found it is good for all other values.

As the formula is one of bodies moving under the action of gravity, it is evident that the constant is influenced by the term "g;" that, however, need not concern us as long as we have to determine the constant anyway by experimental methods, and it is very important that this determination be made under such conditions as will obtain in subsequent practical use.

If the formula is rational and universal, it will apply throughout the entire range of the velocity, but from all the experimental data with which the writer is personally familiar, there seems to be evidence of variability, which, however, is so slight that it does not affect the results except at low flows. Whether this variability is due to viscosity of the liquid, friction, capillarity, cohesion, etc., or to the fact that the parabola is not the true formula of flow is not at present known, but for practical purposes the formula of the parabola is satisfactorily applicable for material velocities.